

3-1 General

This chapter discusses Special Considerations related to modular design, lighting design, acoustic design, design of the thermal environment, seating design and design of audio-visual systems. The material in this chapter is intended to establish special requirements and criteria in conjunction with the individual space criteria in Chapter 4.

3-2 Modular Design

A. Characteristics.

As previously noted, service schools are characterized by frequent changes in instructional program and student load, and by a requirement to be capable of rapidly expanding school operations. The characteristics require a school design which emphasizes flexibility in room use and provides for ease of expansion. The primary classroom requirement at U.S. Army Service Schools is for spaces that will:

- Seat 24 to 48 students.
- Be easily convertible to other uses.
- Minimize disruption of activities during modification of use.

B. Standard Space Module.

Based on the classroom requirements above, the optimum activity space module for service schools is 30 ft. x 50 ft. (Figure 3-1). This 1,500 sq. ft. space:

- (1) Provides ample seating for 50 students at 2 ft. x 3 ft. tables (the most commonly used student situation) in the proper dimensional proportions for conference/lecture activities.

- (2) Is easily divisible, by fixed or movable walls, into two 25 ft. x 30 ft. (750 sq. ft.) rooms for 25-student classes.

- (3) Can be constructed around the 5-ft. dimensional planning unit. (This dimension readily accommodates the standard 4-ft. fluorescent tube and reduces the number of different-sized wall panels needed for construction. See Chapter 5 for additional information on the 5-ft. planning dimension).

C. Modular Arrangement.

The standard space modules should be employed in 30 ft. wide bands along double loaded corridors. (Figure 3-2). This pattern maintains the proper classroom proportions in both the 1,500 and 750 sq. ft. spaces, reduces circulation time by minimizing overall corridor length, and conserves heating and cooling energy by minimizing external wall areas. Moreover, it provides a building pattern which readily accommodates changes in function.

D. Functional Flexibility.

Modular spaces can serve as classrooms, seminar rooms, labs, self-paced learning carrels, instructor preparation spaces, training aids storage areas, and administrative offices with only a change of furniture and the positioning or repositioning of partitions. (Figure 3-3).

E. Interior Wall Systems.

Only the exterior and corridor walls of the modular space banks need be permanent; transverse walls may be either semi-permanent or movable partitions. Semi-permanent walls should be erected in those areas in which a minimum of functional change is anticipated; e.g., in administrative areas. Movable partitions should be employed in those spaces in which changes in

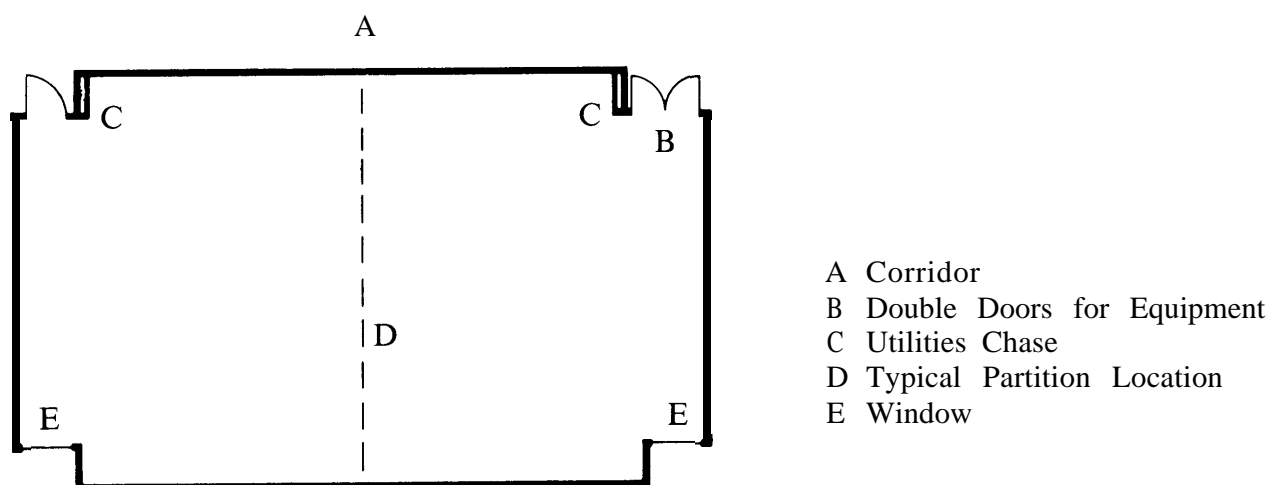
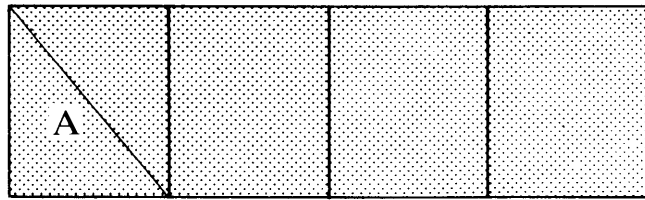
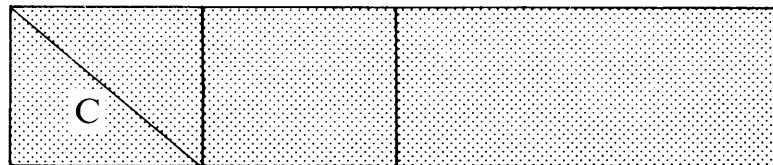
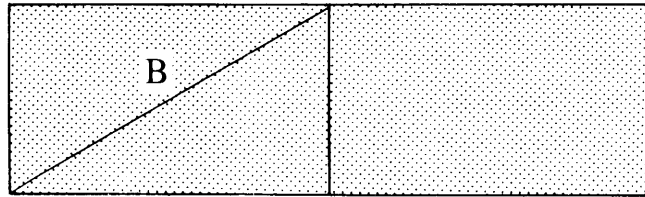


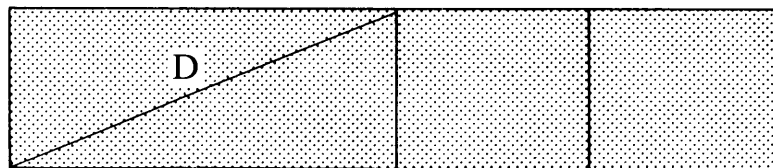
Figure 3-1
Repetitive General Instruction Space



Corridor



Corridor



Correct:

A 30 FT. x 25 Ft.

B 20 Ft. x 50 Ft.

Wrong:

C 25 Ft. x 30 Ft.

D 25 Ft. x 60 Ft.

Figure 3-2
Arrangement of Repetitive Space

function or class size are relatively frequent. Figures 3-4 and 3-5 show some of the basic characteristics of the most common types of movable and semi-permanent interior wall systems. The designer must develop an accurate estimate of the frequency of functional change in a given space, and on the basis of that estimate select an appropriate interior wall system.

F. Partition Systems.

Low height partitions may be used to sub-divide major activity spaces into such areas as self-paced learning carrels, instructor preparation spaces, and administrative offices. The primary consideration here is the degree of interaction desired between work

stations. The height of the partition and the amount of enclosure should be matched to the level of interaction desired. For example, some activities are largely individual tasks requiring little outside communication; e.g., self-paced learning, instructor preparation. In these situations, partitioning must be high enough and complete enough to minimize distractions. Other activities, such as administrative staff planning, require spaces with little or no partitioning so as to promote group interchange. Partitions will be used in this case only to contain the group and reduce interference between it and adjacent groups.

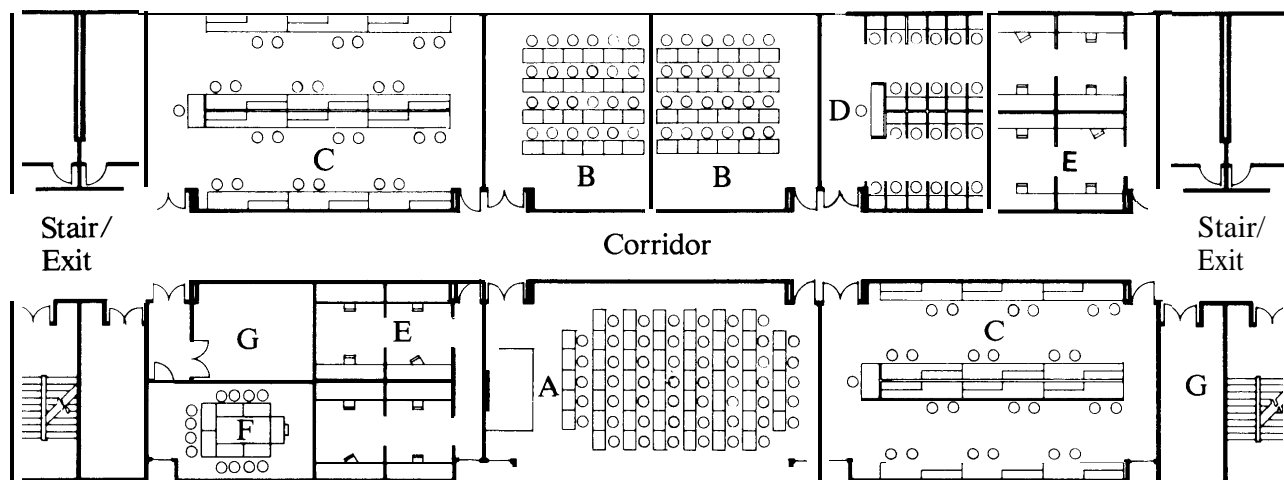
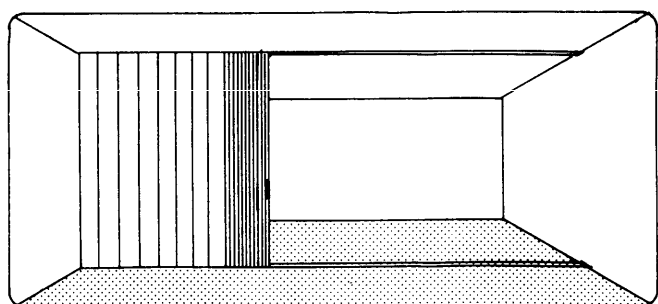
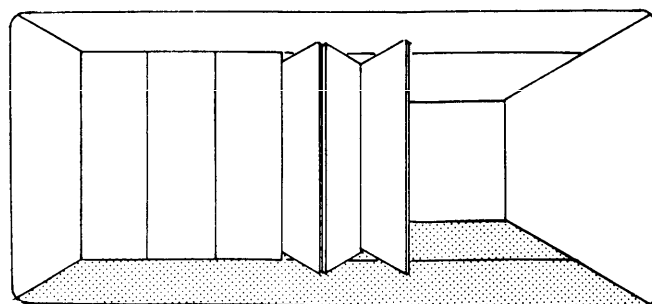


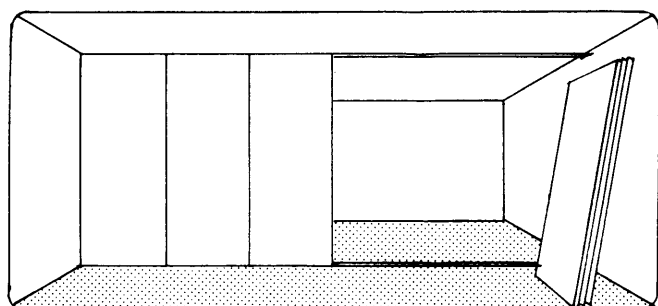
Figure 3-3
Multiple Use of Repetitive Space



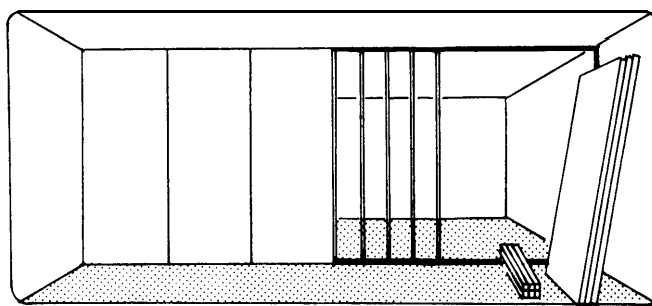
Operable Accordion Wall



Operable Stacking Panel Wall



Portable Panel



Movable Stud Facing Panel Wall

Figure 3-4
Changeable Wall Systems

Partition Type	Relative cost	Change Frequency			
		Hourly	Daily	Monthly	Yearly
Fixed (non-load bearing) 6 " CMU 6" GWB	1	No	No	No	Yes
Moveable	1.8	No	No	Possible	Yes
Accordion	2.6	Yes	Yes	Yes	Yes
Portable	3.2	No	Possible	Yes	Yes
Folding Panel	5.4	Yes	Yes	Yes	Yes

Figure 3-5
Change Frequency and Cost of Wall Systems

G. Support Systems.

For flexibility in the use of modular spaces, mechanical and electrical systems must be designed to adapt to changes in room function. Specific considerations include the following:

- (1) Separate lighting controls shall be provided for each 750 sq. ft. space. These controls should be located near the entrances to provide separate control of the two 750 sq. ft. component spaces within.
- (2) In addition to meeting the visual criteria prescribed below, room lighting should be designed to provide flexibility in lighting levels and arrangements. Lighting should be capable of being adjusted to classroom activities (uniform 70 foot-candle illumination), self-paced learning (uniform background illumination of 30 foot-candles, local task illumination of 70 foot-candles), and audio-visual presentations (screen area darkened, other areas at 30 foot-candles).
- (3) The lighting design should also be easily adapted to spatial divisions other than two 750 sq. ft. areas.
- (4) All activity spaces should be provided with mechanical chases at door recesses. These chases should be easily accessible, of sufficient size to allow additions to services and should feature an electrical

distribution panel on the corridor side and a chase panel on the room side with connections to ceiling and intra-wall conduit runs.

- (5) The minimal wiring distribution system must provide signal and line voltage power. Depending upon the instructional program, additional power distribution may be required for unusual voltage, phasing, or frequency demands.

- (6) Each 750 sq. ft. space should have separate temperature controls. Subdivisions other than 750 sq. ft. spaces will require room heating and cooling system revisions. These revisions must be economical and simple to accomplish.

3-3 Design of Learning Environment

A. Balanced Sensory Stimulation.

The functional and learning capabilities of students are influenced by the sensory stimuli of their environment. Providing the appropriate sensory background for a positive learning environment is not a matter of simply minimizing sensory stimulation. There are optimum levels of stimulation to complement learning activities. For example, a background noise level of approximately 35 decibels of full-spectrum or "white" sound produces optimum alertness and muscle tonus for learning. It has also been shown that people hear

and understand best when the illumination level is high enough to provide a clear view of their surroundings. On the other hand, too much sensory input of any sort distracts the student and causes an inordinate amount of his energy to be expended in filtering out the extraneous input. The sensory stimulating aspects of the environment must therefore be balanced so as to conserve the student's energy, while at the same time providing the necessary stimulation to promote the optimum physiological and psychological conditions for learning.

B. Lighting Design.

(1) Visual Considerations.

An appropriate visual environment with adequate lighting is essential for effective learning. A well lighted classroom enhances auditory as well as visual perception. In the case of a large space not provided with a sound amplification system, lighting is an important factor in the ability of the audience to hear the speaker. Audio-visual aids have traditionally been used in darkened rooms; however, audio-visual devices designed for use in lighted rooms are more effective.

(2) Quantity of Light in Instructional Spaces.

Research has established that a lighting level between 30 and 50 foot-candles is adequate for the comfortable and efficient completion of most tasks. However, it is recommended that illumination be designed to supply 70 foot-candles on all educational tasks, since accurate reading of pencil handwriting demands higher illumination levels than most other visual tasks. Lighting levels higher than 70 foot-candles are not required.

(3) Quantity of Light in Circulation Spaces.

In lighting circulation spaces, an important consideration is the ability of the eye to adapt to light and darkness. Only 35 seconds are required for partial, yet safe, adaptation when moving from a dark space

to a lighted area. When moving from light to dark, however, minimal adaptation requires two minutes, total adaptation up to half an hour. Since personnel entering the service school facility will be coming from the outdoors, where the level of illumination may be anywhere from 2,000 to 5,000 foot-candles, it is important to provide adequate lighting in circulation spaces. Foyers will be bright to permit gradual adaptation to the interior lighting level. Staircases should have high-intensity lighting to outline steps, handrails, and other important elements and show clearly the stair's configuration.

(4) Quality of Light.

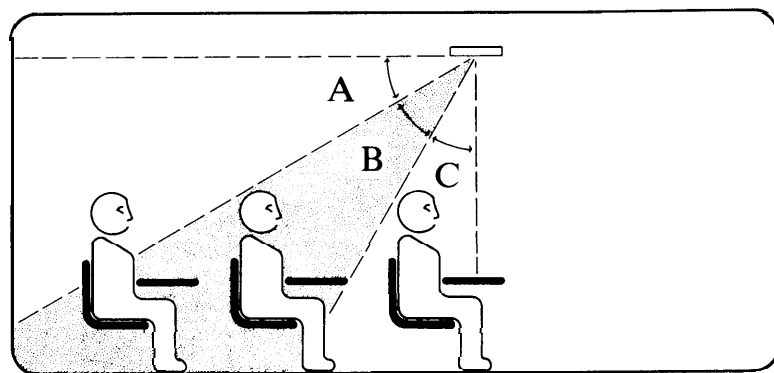
The quality of light is even more important than the quantity. Critical factors here include:

a. Lateral Differences in Illumination.

When personnel are placed in an environment in which illumination on either their left or right is significantly greater than that on the opposite side, their eyes are subjected to distracting and uncomfortable stresses. This situation often occurs in classrooms in which windows allow light to stream in from one side of the students' field of vision. Such conditions can be avoided by designing the seating so that the windows are behind the student or, when this is not possible, by moderating the entering light with shading or other light-attenuating devices.

b. Task-Background Illuminating Levels.

In general, the task (paper, book, item of equipment) confronting the student should be brighter than the surrounding environment. For optimum contour and depth perception, it should be three times as bright. Contrasts greater than this produce distortions. In no case should the task illumination level exceed ten times the general lighting level.



- A 0 Degrees — 30 Degrees
Fixture Glare
- B 30 Degrees — 60 Degrees
Optimum Light
- C 60 Degrees — 90 Degrees
Veiling Reflections

Figure 3-6
Lighting Glare and Reflections

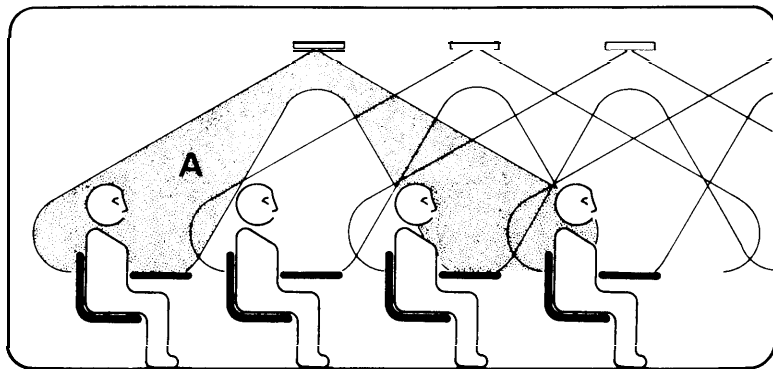


Figure 3-7
Lighting Without Glare

c. Veiling Reflections.

Lighting shall be designed so as to minimize veiling reflections; that is, light which is reflected off the task or nearby surfaces directly into the student's eyes. In general, this involves selecting and placing the light fixture so that the angle of incidence measured from the vertical is greater than 30 degrees, with as much light as possible falling within the 30 to 60 degree core. (Figure 3-6).

d. Glare.

Lighting design shall also minimize glare; that is, light which shines directly from the light source into the student's eyes. This can be accomplished by selecting and placing light fixtures so as to direct the light below a 60 degree angle of incidence, with, again, as much light as possible falling in the 30 to 60 degree core. Lighting fixtures with low brightness characteristics that produce a "bat-wing" light distribution pattern are one means of satisfying this requirement. (Figure 3-7).

e. Audio-Visual Presentation.

Lighting design for A-V presentation is discussed in 3-4.f.

A "Batwing" Distribution

C. Acoustic Design.

(1) Terminology.

Three terms are common to basic discussion of acoustic design in Service Schools: Decibel (db), Noise Reduction Coefficient (NRC) and Sound Transmission Class (STC). Decibel is a measure of intensity of sound related to its subjective loudness. For measuring ordinary sounds, a decibel level of zero represents the faintest sound audible to the average person. Normal voice conversation is approximately 60 db to 80 db. Noise Reduction Coefficient is a mathematical average of sound absorption coefficients recorded at the frequencies of 250, 500, 1,000 and 2,500 cycles per second. The use is to quantify sound systems for comparison. Sound Transmission Class is a rating based on standardized test performance for evaluating the effectiveness of assemblies in isolating airborne sound transmission. A frequency range of 113 to 4,450 cycles per second is included for the standardized test.

(2) Maximum Sound Level.

Loud and sustained noise can be a hazard to hearing. The safe limit for an unprotected ear is approximately

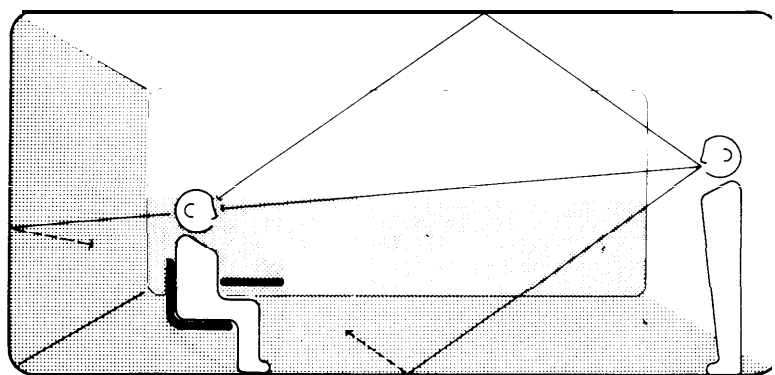


Figure 3-8
Room Sound Control

Sound Reflective Surfaces
Indicated in White

Sound Absorptive Surfaces
Indicated in Tone

135 decibels. At 150 decibels even short-term exposure may cause damage. These facts have important implications for the design of shop areas, where high intensity noise is frequently a problem. The designer must provide some means of attenuating shop noises to protect the hearing of students and shop personnel.

(3) Acoustic Considerations.

The key to providing an acoustic environment conducive to learning consists of controlling background noise while at the same time reinforcing the projection of the instructor's voice.

a. Background Noise.

Background noise other than the white noise discussed in paragraph 3-3a above is distracting. As the background noise level rises, the difficulty of hearing increases. This masking effect is greatest when the frequency range of the desired audio stimuli and the background noise are similar. For example, voice noise of 35 db is more disruptive than mechanical ventilation noise of 35 db.

b. Reflective and Absorptive Surfaces.

In order to reinforce the instructor's voice and help eliminate distracting reverberations in the classroom, the ceiling, the wall behind the instructor, and the upper half of the side walls should be provided with sound reflective surfaces. The remaining surfaces of the room should be sound absorptive so that noise generated close to the floor (e.g., dropping objects, scuffling of shoes, or the moving of chairs) is reduced. (Figure 3-8).

D. Design of Thermal Environment.

(1) Thermal Considerations.

A controlled thermal environment is another important factor in designing comfortable, safe, and effective instructional spaces. Control of the thermal environment includes the following considerations. (For specific requirements related to control for the thermal environment, see Chapter 4, Individual Space Criteria.

a. Temperature is the most important element of the thermal environment. In designing for temperature control, the temperature of surrounding surfaces, as well as that of the air, must be taken into account.

b. Humidity determines the evaporation rate at a given air temperature and thus affects human body temperature by limiting the amount of natural evaporative cooling that can take place. The higher the humidity, the less heat the body can dissipate through perspiration.

c. Air Composition refers to the relative amounts of oxygen, carbon dioxide, and other gases, as well as

airborne particles such as dust, pollen, and bacteria, which make up the room air. The composition of the air greatly affects the comfort and safety of building occupants and hence must be controlled.

d. Air motion is an important thermal consideration because it influences the rate of body heat transfer. The higher the air velocity, the greater the rate of body heat loss.

(2) Human Performance and the Thermal Environment.

Investigations in the area of human performance show that when temperature and humidity become high, working efficiency decreases, errors increase, and under extreme conditions health is adversely affected. In areas such as shops, in which students are working with equipment and machinery, temperature control devices should be provided for safety purposes.

a. Temperature Control.

Whenever the daytime outside temperature is above 55 degrees F., heat gains will usually outweigh losses. Therefore the fundamental problem in controlling the thermal environment in a service school is cooling, rather than heating, the facility. The desirable temperature for a building depends on the activity of its occupants. Acceptable temperature limits vary from 60-70 degrees for vigorous activity to 68-78 degrees for sedentary activity. In a service school, where learning activities range from sedentary to vigorous, separate temperature zoning should be provided. For example, shop areas should be zoned for a lower temperature than classrooms or administrative areas.

b. Humidity Control.

This generally is not necessary. Relative humidity has little influence on comfort, provided that it is in the intermediate range (30% to 70%). Humidity levels above 70% can impair human performance and levels below 30% can cause respiratory discomfort and create undesirable levels of static electricity in activity spaces.

c. Air Composition.

This should be carefully controlled. In a closed, occupied space, the amount of oxygen in the air decreases and the amount of carbon dioxide increases. Normally, ventilation sufficient for the removal or dissipation of odors is also adequate for maintaining the proper balance between oxygen and carbon dioxide. Dust, pollen, and bacteria should be eliminated by air filtration.

d. Air Motion.

This is another factor requiring control. Air distribution systems should provide uniform air

velocities generally not exceeding 40 feet per minute for an air-conditioned draft-free environment. If the building is not air-conditioned a higher air velocity increases summer thermal comfort.

E. Seating Design.

(1) Instructor-Student Visual Contact.

Arranging seating to facilitate instructor-student visual contact is of primary importance. Students sitting directly in front of the instructor participate significantly more than students sitting off to one side. Seating arrangements should therefore encourage direct visual contact between instructor and students. (Figure 3-9). In a classroom containing several rows of seating, a speaker's platform is required; in a large conference room or an auditorium, tiered risers for student seating are required.

(2) Seating Comfort.

Seating which is too comfortable may discourage student participation and alertness. Seating should be selected which is reasonably comfortable, but not so relaxing that it encourages inattentiveness.

3-4 Design of Audio-Visual Systems

A. Configurations.

U.S. Army Service Schools use A-V equipment in six general configurations shown in Figure 3-10.

B. Storage.

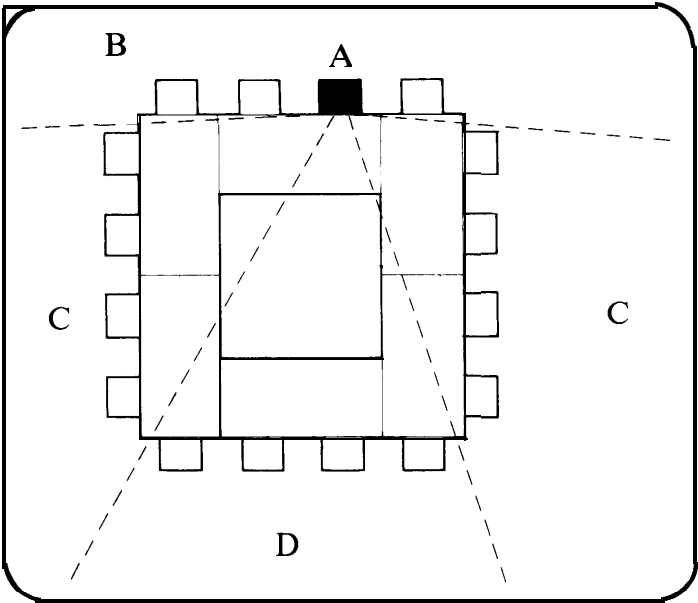
Sufficient space should be programed within the school to allow for the storage and maintenance of A-V equipment and materials. This space is, at a minimum,

that necessary to meet day-to-day operational requirements. It can be determined by analyzing specific instructional programs on a school-by-school basis. This space will be located in the technical library, training aids offices, or other area close to classrooms and instructor preparation areas. Paragraph 2-4c.(2)(m) above contains additional information on storage areas. The A-V storage space required can be determined from the following table:

	Storage Volume (Units per Cubic Foot)
Media	
16mm film (400 ft. reels)	9 reels
Film strip	160 strips
8mm film loops	45 loops
35mm slides	535 slides
Audio cassettes	143 cassettes
7 inch reel audio tape	42 reels
Long playing records	40 records
Overhead project transparencies	64
Microfilm 35mm	34 films
Microfilm 16mm	68 films
Microfiche	1,785 cards

C. Visual Field.

Although the eye can perceive objects over an extremely wide visual field (a horizontal arc of approximately 200 degrees), the major visual field consists of a cone of 30 degrees - 15 degrees on either side of center. It has been estimated that 70% of all vision takes place within this field. To occupy the full 30 degrees visual field, a display must be located at distance from the eye equal to twice the width of the display (2W). Effective viewing, then, requires a minimum viewing distance of 2W. (Figure 3-11). The



- A Instructor
- B Zone of Minimum Participation
- C Zone of Average Participation
- D Zone of Maximum Participation

Figure 3-9
Visual Contact/Discussion Participation Relationship

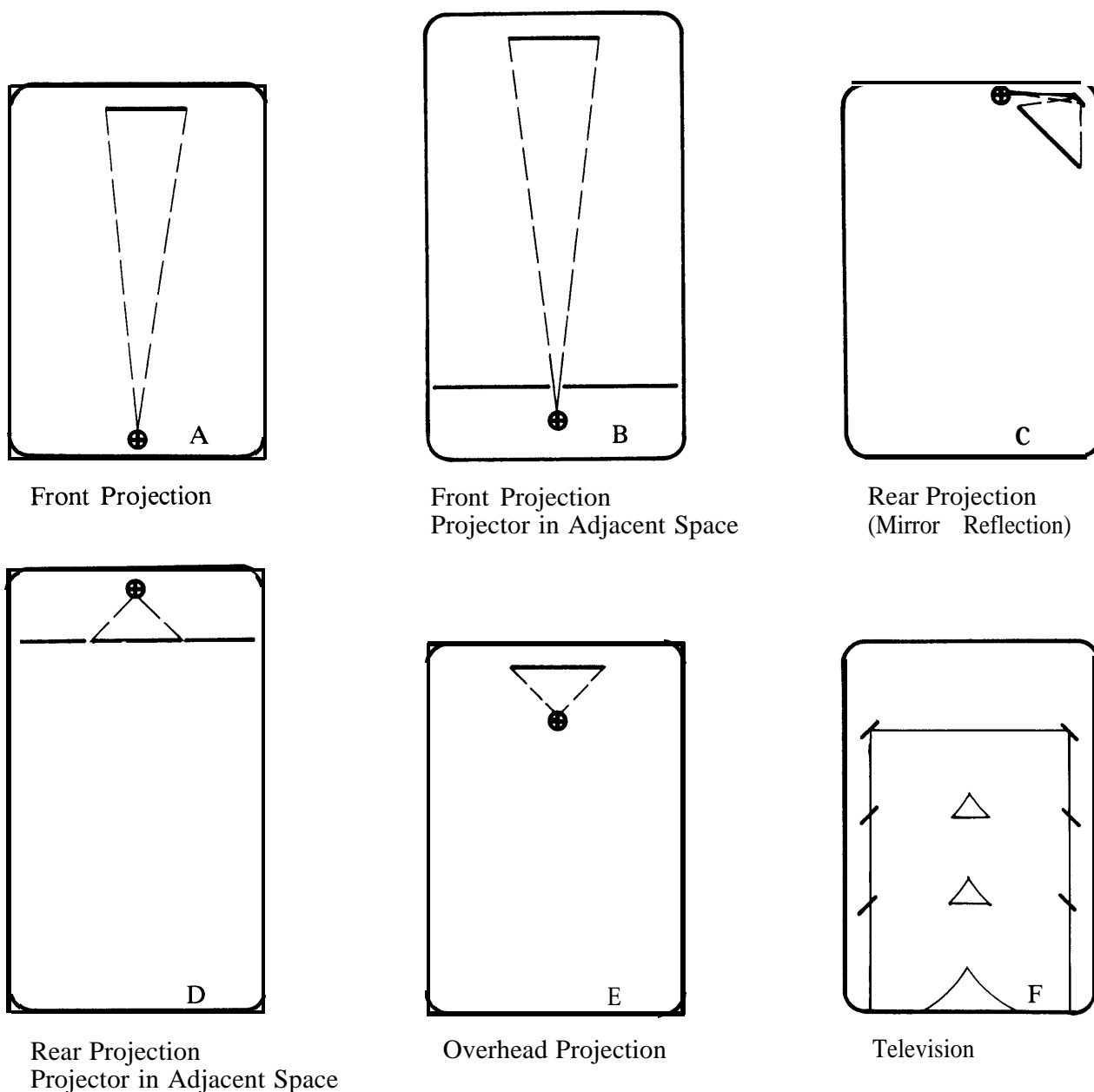


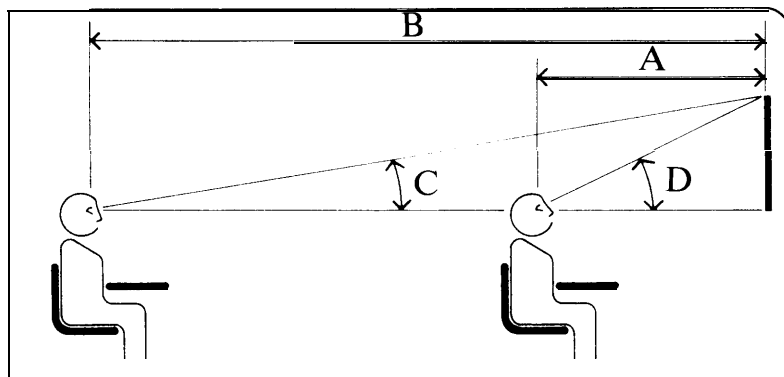
Figure 3-10
Configurations of Audio-Visual Systems

optimum visual field, however, is even smaller. Research has established that this field is approximately 9 degrees, which represents an optimum viewing distance of $6 \frac{1}{4} W$. (Figure 3-11). These data shall be considered in the design of all school activity spaces and are especially important in the design of audio-visual facilities.

D. Audio-Visual Presentation Systems.

There are two general categories of A-V systems: tube

screen (used for television, both central broadcasts and videotapes) and reflected screen (used for movies, slides, overhead projectors, and projected television). Reflected screen devices, in turn, fall into two categories: front and rear projection systems. Each of these A-V systems places different requirements on the design of an instruction space. Projected television is the most complex of these systems and has the most demanding requirements for precision installation and



- A 2 (width of screen)
- B 6.25 (width of screen)
- C 9 Degrees
- D 30 Degrees

Figure 3-11
Projection Screen Location Related to the
Cone of Vision

operation. These characteristics should be carefully investigated prior to programing a projected television system.

(1) Tube Screen Viewing Characteristics:
(Figure 3-12).

- a. The maximum viewing area extends 45 degrees each side of center, forming a "visual cone" of 90 degrees.
- b. The minimum viewing distance (that is, the closest the spectators may sit to the screen) is 5W (five times the width of the screen). The preferred minimum viewing distance, however, is 8W.
- c. The maximum viewing distance is 14W; the preferred maximum is 10W.
- d. The bottom of the screen must be 48 inches from the floor to permit unobstructed viewing by all spectators.
- e. "W" for tube screen is practically limited to a 25-inch screen unit (actual visual "W" approximately 22 inches). However, tube screen equipment is improving, and larger, more economical screens may be developed. The availability of such screens must be investigated when audio-visual systems are programed.

(2) Reflected Screen Viewing Characteristics:
(Figure 3-13).

- a. The maximum viewing area extends 50 degrees either side of the screen. The preferred area, however, extends 40 degrees.
- b. The minimum viewing distance from the screen is 2W, but 4W is the preferred minimum.
- c. The maximum viewing distance is 8W, 6W the preferred.

d. The bottom of the screen must be 48 inches from the floor; the top may extend to within 6 inches of the ceiling.

e. Reflected screens are not limited in size.

(3) Comparison of Front and Rear Projection Systems.

With a front projection system, images are projected onto an opaque screen from a location in front of the screen. Rear projection systems project an image onto a translucent screen from a position behind the screen. The following is a comparison of the two systems in terms of their spatial impact on classroom design:

a. Shadows on Image.

Rear projection systems permit lecturing and demonstrating concurrent with medial projection, with no obstruction of the image by shadows. With front projection systems this is more difficult to accomplish.

b. Location of Projector.

Front projection equipment is located at the end of the room opposite the lecturer. This necessitates either remote operation, an attendant, or automatic delivery. Rear projection equipment located in a separate projection room presents the same problem. However, it may also be located beside the lecturer, with the image being projected onto the rear of the screen by a series of mirrors. This system permits manual control of the projector by the lecturer, and facilitates the handling of projector malfunctions.

c. Audience Size.

Given equally sized screens of equal brightness, a front projection system permits more persons to be seated within the favorable viewing area because the projector is farther from the screen. As Figure 3-14 shows, theoretically it would be possible to locate a rear projector at a distance from the screen of 6W, thereby

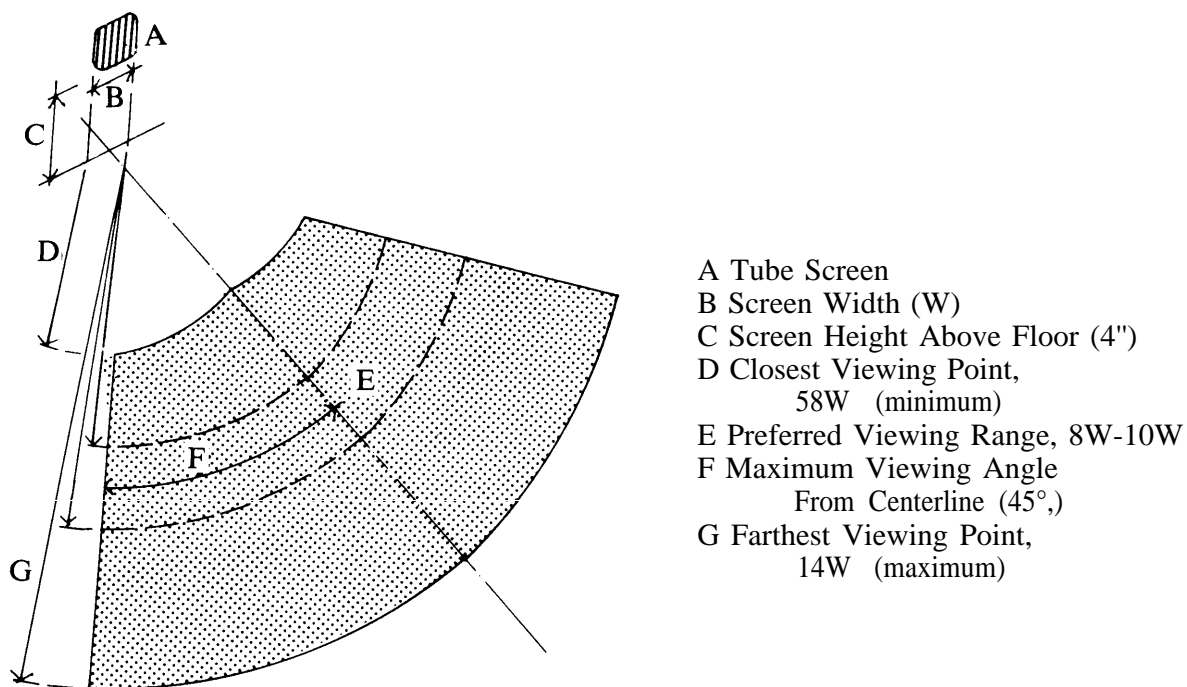


Figure 3-12
Television Tube Screen Viewing Criteria

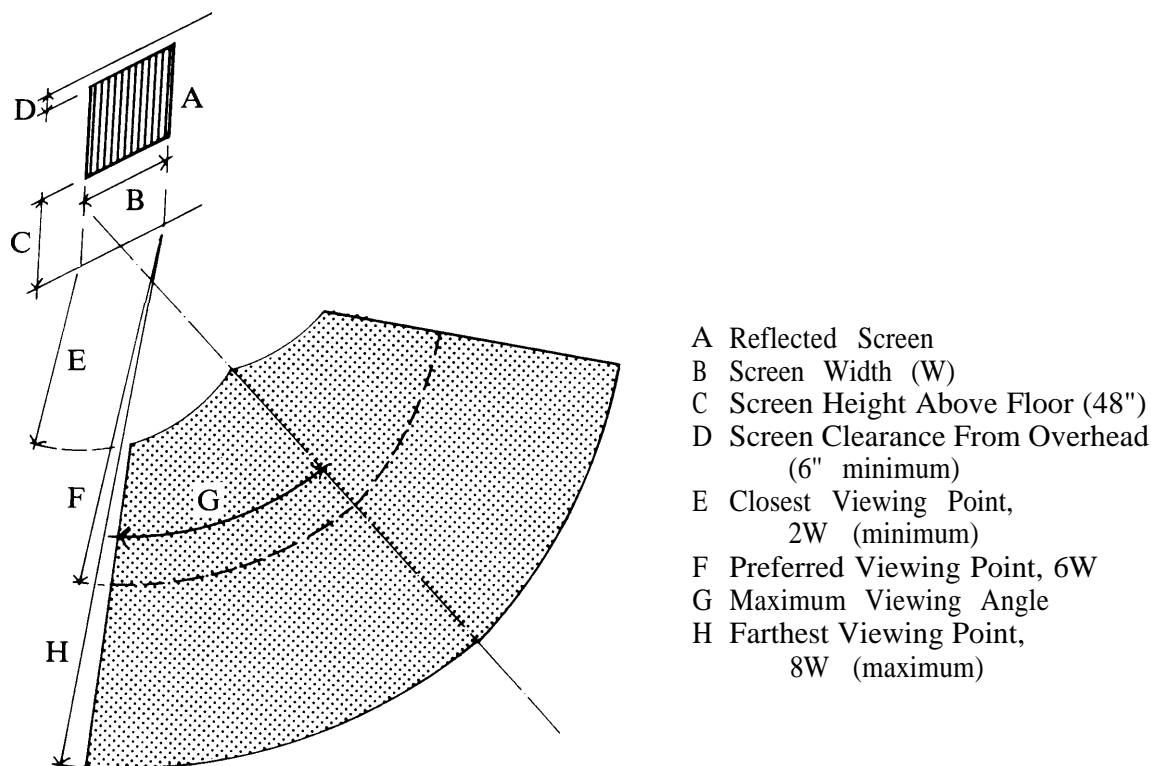


Figure 3-13
Reflected Screen Viewing Criteria

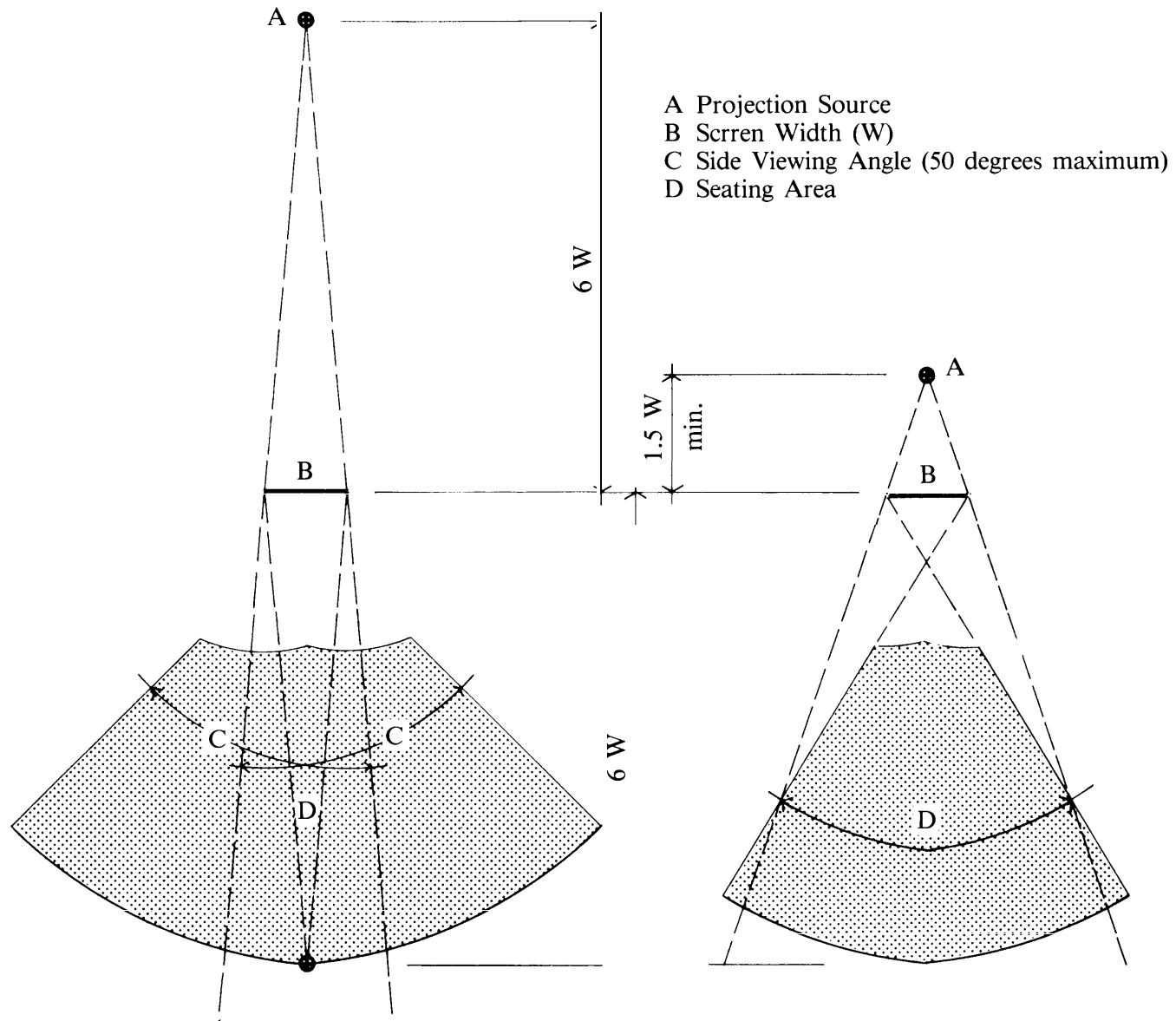


Figure 3-14
Comparison of Seating Areas,
Front and Rear Screen Systems

achieving the same seating space as with a front projector. However, in practice this is not feasible, as it would result in grossly inefficient space utilization. As the diagram indicates, with the typical distance of $1.5W$ between rear projector and screen, the seating area would be approximately two-thirds that of a front projection system.

d. Space Utilization.

Front projection systems utilizing projection rooms require less space than similar rear projection systems, due to the required distance between screen and rear projector of $1.5W$. (Figure 3-15). However, rear projection systems which locate the equipment in the

classroom rather than in a separate projection room and use mirrors to achieve the necessary distance to the screen, require no more space than do front projection systems. (Figure 3-16).

e. Flexibility.

Rear projection screens located in separate rooms limit the flexibility of the building by interposing dedicated space between non-dedicated classroom spaces.

f. Image Quality.

Front projection systems afford better image quality over a broader seating area than do rear projection systems. (Figure 3-17).

g. Economy.

Rear projection systems are considerably more costly than front projection systems, initially and over the life of the facility. Separate rear projection rooms provided indiscriminately to all classrooms could raise the required area for a school (and the total cost) as much as 25%. In addition rear projection systems are essentially static and complete equipment would have to be provided in each classroom with a projection requirement. Front projection systems are highly portable and can be furnished on a check-out basis as needed; therefore fewer pieces of equipment need to be procured. The screens and projectors for rear projection equipment are generally more costly than those for front projection.

h. Conclusions.

Front projection systems are more economical and permit more efficient utilization of space and equipment: the seating area is larger, the image quality is better over a greater area, fewer pieces of equipment

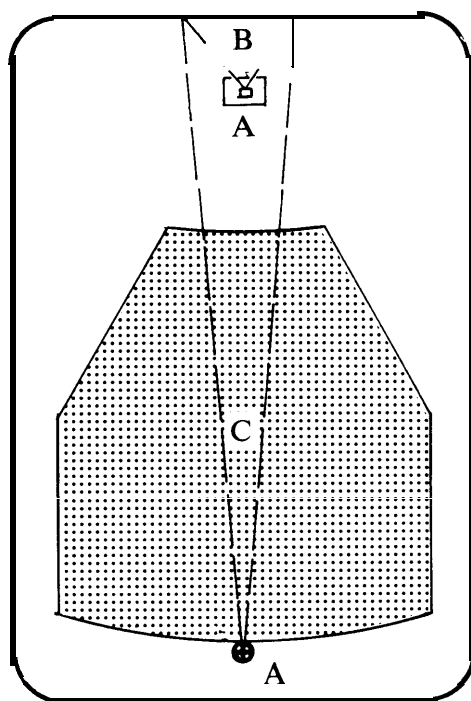
are required to serve the needs of the school, and less space is required for the projection. Rear projection systems are preferable from the lecturer's point of view; the projecting equipment can be nearby, (either in an adjacent enclosed space behind the lecturer or next to the lectern, with the image projected by mirrors), giving the instructor manual control, and there is no shadow interruption of the image. In view of the above, requirements for rear projection systems should be carefully reviewed by each school and fully justified in Project Development Brochures.

E. Viewer Sightlines.

In determining the design of a space to be used for A-V presentations, viewer sightlines are the most important consideration. There are several factors contributing to viewing ease:

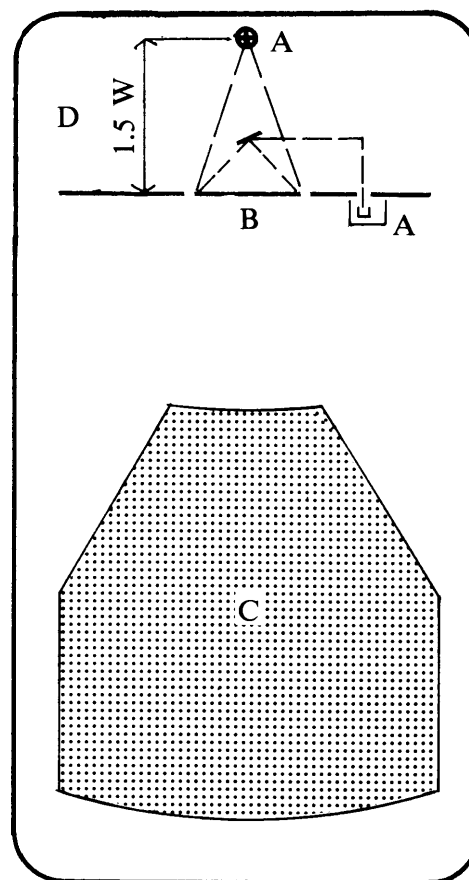
(1) Sloped Floor.

Audiences of more than fifty people generally require



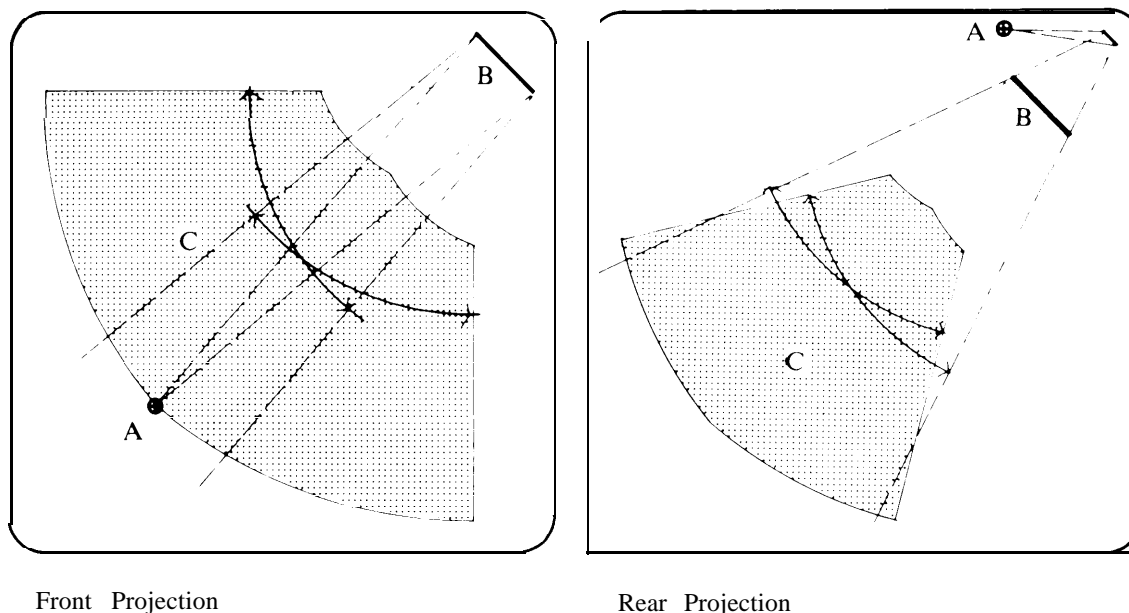
Front Projection

- A Projection Source
- B Screen Width (W)
- C Seating Area
- D Projection Room (dedicated space)



Rear Projection

Figure 3-15
Comparison of Total Space,
Front and Rear Screen Systems



A Projection Source
 B Screen
 C Seating Area

Figure 3-16
Comparison of Space Utilization
Front and Rear Screen Systems

sloped floors. In rooms designed for television viewing, an alternative is to install the television sets along perimeter walls.

(2) Square Room.

A room of approximately square shape is best for A-V presentations; excessive width or length will cause visual and acoustic distortions.

(3) Image Distortion.

As the distance of the viewer from the room's center increases, so does the image distortion. Figure 3-18 indicates the amount of distortion occurring at various viewing angles.

(4) Relationship Between Viewing Area, Screen Height, and Ceiling Height.

Generally, the screen height is determined by the room's ceiling height. The screen must be at least 4 feet above the floor and typically 6 inches from the ceiling. A screen width is then selected so that the screen's proportions are compatible with the proportions of commonly projected images. The screen width, together with the nature and location of the projection source, establishes the recommended viewing area. The ceiling should be high enough to insure necessary image sizes on the project screen, provide all

students a good view of the screen, and prevent students' heads from casting shadows on the screen when using rear projection. Ceilings higher than 12 feet are seldom required, but should not be less than 9 feet high. If a projection screen is used, the required ceiling height, C (feet), can be found using the equations below and assuming that the bottom of the screen will be placed 4 feet above the floor and that the distance between the top of the screen and the ceiling will be 6 inches. For horizontal image formats, where the image height is less than or equal to the screen width, W (feet) is divided by 1.33:

$$C = 4.5 + \frac{W}{1.33}$$

where the room length, L (feet), is 6W. This can be simplified to establish a direct relationship between L and C:

$$L = 8C - 36$$

For vertical image formats, where the image height is greater than or equal to the image width:

$$C = 4.5 + W$$

and

$$L = 6C - 27$$

If vertical formats (slides) will also be used, the screen height value H is equal to W, and will require additional height.

(5) Full and Partial Viewing Sectors.

For a given screen size, using the maximum viewing area permits a greater number of seats than does a partial viewing sector; however, it results in less efficient utilization of space, as only 30% of the room can be occupied by seats. By using a more rectangular room, seating area is decreased by one-third, but room space is utilized more efficiently: seats may occupy 40% of the room. (Figure 3-19). Furthermore, the seating eliminated by this arrangement is that portion of the seating located along the least desirable viewing angles.

F. Lighting Design for A-V Presentation.**(1) Controls.**

Room lighting must be controlled for different media and viewer tasks. The controls must be conveniently

located near the screen, easy to operate, and allow complete control by a single person.

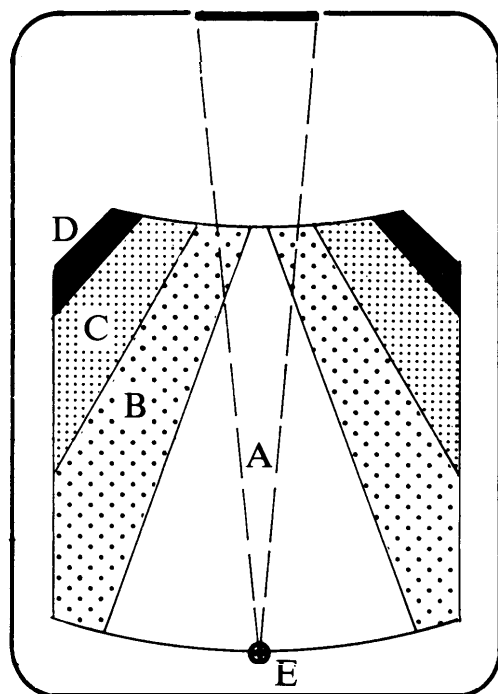
(2) Lighting Levels.

Room ambient light level should be between 10% and 33% of the screen (or tube) brightness. Recommended ambient light levels for particular media and output sources are:

Media	Source	
	Normal	High-Output
16mm film	5-10 fc	15-25 fc
35mm slides	15-25 fc	25-35 fc
Videotape	Projected	
Television	35 fc	4-10 fc

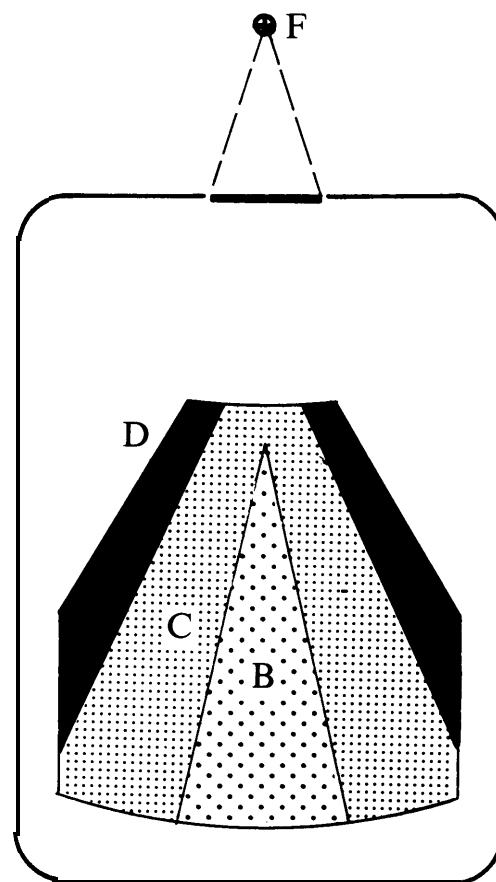
G. Ventilation.

Criteria and design of mechanical systems for A-V rooms shall be identical to the classrooms served.



Front Projection

- A Excellent
- B Very Good
- C Good
- D Fair
- E Front Projection Source
- F Rear Projection Source



Rear Projection

Figure 3-17
Comparison of Image Quality,
Front and Rear Screen Systems.

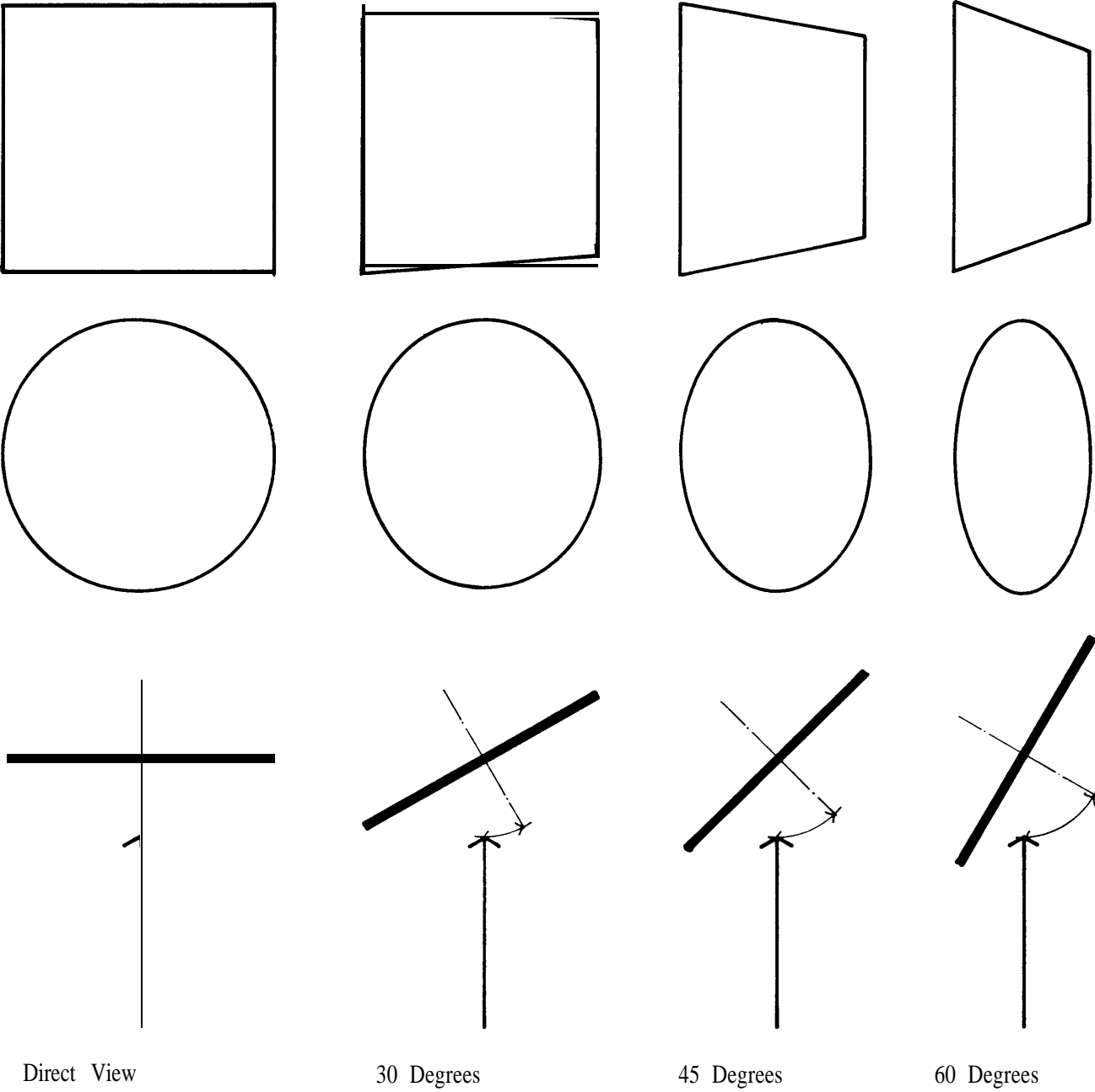
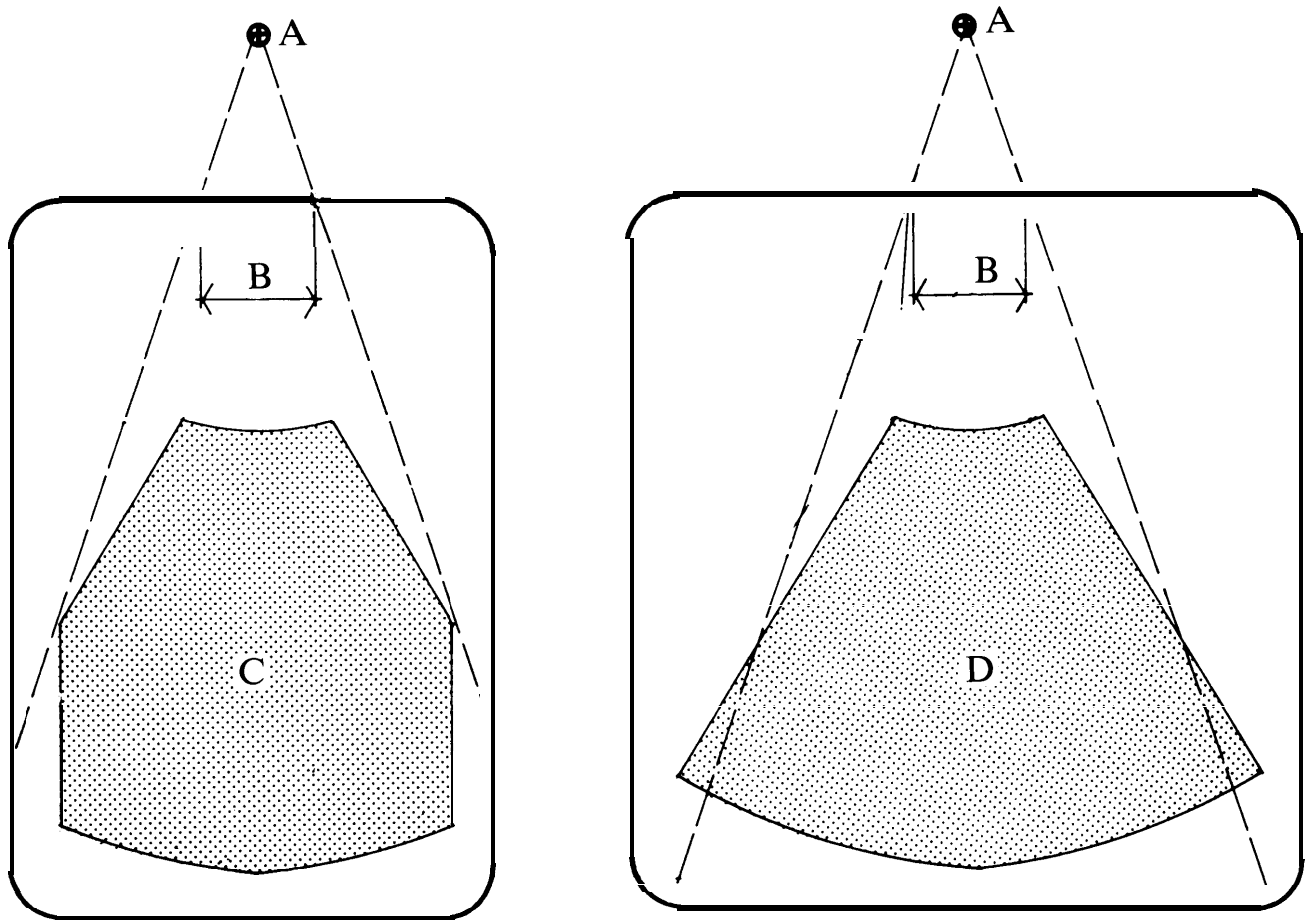


Figure 3-18
Image Distortion.



- A Projection Source
- B Screen Width (W)
- C Seating Area Partial Viewing Sector
(40% room area)
- D Seating Area Full Viewing Sector
(30% room area)

Figure 3-19
Seating in Partial Viewing Sector